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T' MONTHLY PROGRESS REPORT

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1963 Submitted by

NEW PRODUCT RESEARCH of TAPCO

OTS PRICE

### I INTRODUCTION

This document represents the eighth monthly report covering the work on the experimental program for development of an "Osmotic Still" and improvements in the performance characteristics of the Ionics Dual Membrane Fuel Celliduring the month of February 1963. This development work is being accomplished under NASA-Lewis Research Center Contract No. NAS 3-2551 by the New Product Research Department of TAPCO, and Ionics Inc. as a subcontractor to TAPCO.

### II OVERALL PROGRESS

## A. Tapco Portion of Program

- 1. Ionac membranes MC 3142, MA 3148, XLMA 3236, and XLMC 3235 were tested for liquid leakage at room temperature after being soaked in water at toom temperature for 16 hours. All but the XLMC 3235 showed no leakage with a pressure difference of 16 psi. The XLMC 3235 leaked with a 15 psi pressure difference.
- 2. The same membranes were pressure tested at room temperature after being pretreated in 180°F (recommended by Ionac) water for four hours. All membranes leaked excessively at pressures differences from 2 to 10 psi.
- 3. Performance tests were attempted with the MC 3142 and the MA 3148. The MC 3142 was pretreated in 180°F water before installation and excessive leakage occurred immediately upon evacuation of the vapor chamber before acid heatup.

The MA 3148 was run for approximately four hours at temperatures of 125°F and 140°F, but extremely small amounts of liquid were extracted during this period and a phl wasnever exceeded. Thus, the above Ionac membranes were determined unsuitable and testing of these membranes was discontinued.

- 4. Five successful test runs were completed with the AMF C-60 membrane at temperatures from 150°F to 200°F and at vapor pressures from .45 psia to 1.23 psia with an acid concentration of 25.2%.
- 5. A total of 15 successful test runs were made with the AMF C-60 membrane at 200°F and acid concentrations from 15.2% to 60%.
- 6. Two tests on this membrane were made with acid pressures of 26 psia and 32 psia at 200°F and 25.2% concentration.

- 7. The AMF C-60 membranes used in the tests during this reporting period are the same membranes used during the last reporting period and the Kel-F coated support screens have been used throughout all the tests and appears to be in good condition.
- 8. Porous Kel-F and porous polyethylene were leak tested as non-wetting materials, but were determined as unsatisfactory.

## B. <u>Ionics Portion of Program</u>

- 1. Progress was made in the areas of test rig control and operation, membrane and electrode screening, successful life testing, delineation of the source of liquid in the cell gas streams, determination of the effect of gas circulation rates on cell performance, finalizing the design of and expediting procurement of materials for the multiple cell batteries.
- 2. Revemping of test rig controls and operation has led to successful long-term tests of fuel cells without any premature failures.
- 3. Continued screening tests in small (4 sq. in.) test cells reinforced the finding that we are now using the best membranes (IONICS 61-AZG and 61-AZL) and electrodes (platinum black sintered with teflon) that are available.
- 4. Long successful runs of single cells up to 500 hours and still running have been achieved while meeting the electrical output requirements.
- 5. The liquid appearing in the gas streams was shown definitely to have come through the membranes. Rates of liquid appearance were determined.
- 6. Wide variation in gas rates was shown to have no effect on cell output, thus simplifying eventual system control problems. The pressure drop through a single cell was shown to be small even at gas circulation rates 20 times the consumption rate indicating that power losses for gas circulation will not be serious.
- 7. Design modifications based on our findings were made and finalized design drawings for multiple-cell battery components prepared. Procurement and fabrication is in full swing.

### II. CURRENT PROBLEMS

### A. Tapco Portion of Program

There have been no major problems during this reporting period.

### B. Ionics Portion of Program

1. Delivery of ordered materials and fabrication of components needs additional expediting.

### IV NEXT MONTH'S EFFORT

## A. Tapco Portion of Program

- 1. Complete performance tests on the AMF C-60 membrane.
- 2. Select design point for 2 KW still design and make preliminary gasket tests for 2 KW design.
- 3. Design 2 KW still and test rig.

## B. Ionics Portion of Program

- 1. Expedite receipt of ordered materials.
- 2. Complete fabrication of all components for 5-cell batteries.
- 3. Complete modifications to test rig to permit testing 5-cell batteries.
- 4. Finalize technique for assembling, venting and filling multiple-cell batteries.
- 5. Assemble initial two 5-cell batteries.

#### V TEST RESULTS

#### A. Tapco Portion of Program

- 1. The initial test with the Ionac MC 3142 membrane was made in the test unit after the membranes had been soaked in 180°F water for four hours (recommended by Ionac representative). Upon initial evacuation of vapor chamber prior to acid heatup, the membrane leaked acid excessively with a vacuum of only 20 cm mercury. Upon removal of the membrane from the test unit, inspection showed no rupture in the membrane.
- 2. Leakage tests were made on the Ionac membranes after soaking in room temperature water for 16 hours. These tests were made by securing the membrane over a 3/8" diameter hole and exposing one side of the membrane to pressurized water and the other side of the membrane to atmospheric air. Leakage was determined by visual observation. The water pressure was gradually increased to determine where leakage was visible.

Membrane	Water Pressure	Pressure Duration	Results
MC 3142	16 psig	16 hrs	No leakage
MA 3148	16 psig	1 hr	No leakage
XLMA 3236	16 psig	1 hr	No leakage
XIMC 3235	15 psig	1 hr	Small leakage at first but increased with time

3. Leakage tests were made on the same membranes after soaking in 180°F water for four hours.

Membrane	Water Pressure	Results
MC 3142	2 psig	Rapid leakage
MA 3148	10 psig	Small leakage
XLMA 3236	8 psig	Rapid leakage
XIMC 3235	3 psig	Rapid leakage

4. Leak tests were made on two non-wetting porous materials. A sample of porous Kel-F sheet with pore size under 7 microns and a sample of porous polyethylene sheet with pore size under 2.0 microns were obtained from the ESB Reeves Corporation. The tests were made with water at room temperature.

Sample	Results
Porous Kel-F	Leaked at 7 psig
Porous Polyethylene 13-CN	Leaked at 3.5 psig

5. Attached are plotted data obtained on the AMF C-60 to date. (TRW Fig. 1A) Also, attached are performance test raw data for this reporting period.

## B. Ionics Portion of Program

### 1. Test Rig Revemp

Many cells previously had to be taken off test prematurely due to malfunction of the test rig control system. The test rig and test procedures were revamped and no premature (less than 100 hour) malfunction has occurred since. The major changes included:

- 1. Operation at 5 psig instead of 15 psig.
- 2. Additional instrumentation to ensure that the pressure in each gas compartment and each electrolyte compartment was 5 ± 0.3 psig.
- 3. Gas manifold changes to ensure that gas pressure remained constant during gas supply changes.
- 4. Additional operator instruction to ensure that the pressure differential between gas and electrolyte compartments did not exceed 1.5 psi during startup.
- 5. All tygon tubing in the oxygen system has been replaced with polyethylene to prevent the occasional fires which had been noticed in these lines.

## 2. Single 4 sq. in. Cell Studies

### 2.1 Membrane Studies

The effect of various membranes on cell resistance was investigated at Ionics and as part of a subcontract at Arthur D. Little. In addition, the appearance rate of liquid in the gas compartments was measured in the cells tested at Ionics.

Six different types of membranes were studied at Ionics: 61AZG (Ionics Standard), 61-DYG, 61-AZL, 61-AZL-15, 61-AZL-8, and AMF-C313. The 61-AZG, AMF C-313 and AMF C-60 were studied at A.D.L. Hydrogen and oxygen were bubbled through 6N H2SO4 prior to being fed to the cells so as to saturate the gases with water vapor. Liquid coming out of the two gas compartments was collected in small graduated cylinders. Standard sintered electrodes were used in these cells. Results obtained are summarized in Table 1. The relative cell resistances were obtained from the slope of current vs. voltage plots. All the cells were run at a current of 400 ma, except when current vs. voltage curves were being obtained. Cells containing 61-AZL and 61-AZG showed the lowest resistance -0.26 and 0.31 ohms, corresponding to cell specific conductances of 138 and 116 mhos/ft2. This may be compared to values up to 140-180 mhos/ft<sup>2</sup> found for the 36 sq. in cells. The larger cells may be showing a higher specific conductance because the electrolyte compartments are thinner: 0.060" in the 36 sq. in. cells vs. 0.625" in the 4 sq. in. cells. The amount of liquid collected was very low and varied from negligible to 1.5 ml per day compared to 3.2 ml/day produced from the fuel cell reaction.

Overall, 61-AZG appears the most desirable membrane with 61-AZL a possible second. The AMF membranes had previously shown considerably poorer stability than 61-AZG or 61-AZL on continued exposure to 6N sulfuric acid at elevated temperatures.

### 2.2 Electrode Studies

Several different types of electrodes were tested at Ionics and under subcontract at Arthur D. Little.

### 2.2.1 Clevite Electrodes

Clevite Corporation made two electrodes (sintered type) using a lighter grade of MgO powder in the paste. Performance of these electrodes was very poor and voltages were taken only at 0.4 and 0.67 amps.

		VOLTS -	
AMPS	TOTAL	H2	02
0.4	0.407	0.147	0 <b>.2</b> 63
0.67	0.313	0.100	0.207

These voltage readings were considerably lower than voltages obtained from the sintered electrode used before: e.g., 0.76 total volts at 0.4 amps. These new electrodes were pressed at a very high pressure (10,000 psi compared to our normal 4000 psi). This might have caused low porosity, resulting in low meter readings.

### 2.2.2 Mott Electrodes

Mott Metallurgical Corporation prepared sintered platnimum black electrodes. These are circular and have an area of 2.95 sq. in. A characterization curve is shown in Figure 1. The values obtained here are also very low: 0.4 total

volts at 0.4 amps. The cell had a specific conductance of 120 mhos/ft2. The oxygen electrode was sprayed with teflon and then tried in the cell. The performance of this cell was even poorer than the above. Current more than 80 ma could not be drawn.

# 2.2.3 Imprinted Electrodes (ADL)

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It appeared first that a technique of imprinting the membrane with Pt black would improve the catalyst membrane contact as experiments of this type had been performed by Gregor(1), (2) with some success. Series 100 AMF membranes had been subjected to 60,000 psi and 115°C to imbed Pt black and had performed well in single membrane cells with no free electrolyte. However, further experiments reported by Perry(3) in which imprinted cation membranes were used in a dual membrane alkaline cell gave polarization curves no higher than those reported by Lurie et al.(4) for similar cells with unimprinted Ionics membranes. Attempts to imprint both Ionics and AMF membranes at lower temperatures (to prevent membrane drying) had proved unsuccessful and were discontinued in the light of Perry's report.

# 2.2.4 Deposited Electrodes (ADL)

Chemical reduction of platinum compounds to metal in and on the membrane was attempted in an effort to put more active catalyst in intimate contact with the membrane. The soluble Pt (NH3) Cl2 complex was prepared by treating a chloroplatinic acid solution with excess ammonia and the membrane surface washed with this solution. The membrane was then flushed with a basic solution of sodium borohydride, reducing the complex to finely-divided platinum and various soluble salts. While a darkening of the membrane was observed which could be attributed to the presence of platinum, it was not possible to build up any appreciable concentration at the surface of the membrane, the only area in which it would be accessible to gaseous H2 and so useful as a catalyst.

An attempt was also made to use this impregnated membrane as a cathode and deposit upon it electrochemically Pt black from standard platinizing solutions. This also proved unsatisfactory as no significant current density could be obtained, showing that even with reduced platinum present, the surface of the membrane was still not the electronic conductor required for this technique.

# 2.2.5 Pure Platinum Electrodes (ADL)

The presence of Teflon in the Pt paste has seemed a possible source of trouble as it places an electrically insulating material in the electrode-catalyst region. Taschek and Wynn (5) report that it may introduce as much as 70 mv additional ohmic polarization when used as wet-proofing material in place of the more common but less durable paraffin. A fuel cell was prepared in which a thin layer of pure Pt black was sandwiched between membranes and electrodes, the electrodes having been well coated with Pt black electrochemically. The polarization curve is shown in Figure 2. After four days it showed no deterioration due to lack of wet-proofing although this would certainly have become a problem at a later time. The conclusions to be drawn from these curves is that at the low current densities concerned, about 700 ma for the small cell, voltage loss is due in overwhelming part to the initial electrode polarization and efforts to reduce the limiting slope have little effect upon the immediate application of the cell. Reports from Ionics concerning a cell with teflon present primarily on the oxygen side give a limiting slope of about 0.2 ohms for the cell but a voltage at 700 ma again of about 0.65 v, the same voltage is obtained both with and without teflon. The problem is thus one of catalysis rather than internal resistance of the cell components. Further work should then be concerned with this problem.

# 2.2.6 Platinized Carbon Electrodes (ADL)

As one step toward investigation of the catalysis problem, a pair of platinized carbon electrodes were prepared according to the method of Taschek and Wynn . Two 2' x 2" x 3/32" pieces of PC 57, manufactured by the Stackpole Carbon Company, were chosen. This material has a porosity of 1.07 cc/g and surface area of about 300M<sup>2</sup>/g. Pores range from 3 to 7 microns in diameter. These blocks were wet-proofed by soaking in a solution of 2 g paraffin in 100 ml petroleum ether, dried, and thenheated to 200°C for two hours. While still hot, they were painted with a 10% solution of H2PtCl4, using enough solution for a coverage of 2 mg Pt/cm<sup>2</sup>. They were then dried in an oven at 100°C for several hours and transferred to a vacuum oven at 150°C for five more hours to decompose the platinum compound.

The prepared carbon was put into the cell with the treated surface against the membrane and electrical contact was made by platinum gauze pressed against the back of the carbon. Resistance of the assembled cell was 0.4 ohm, measured with a Kiethyley Model 502 Multiohmeter. A polarization curve for this electrode system is also shown in Figure 2.

## 2.2.7 Bibliography for ADL Electrode Study

- 1. H. P. Gregor, "Fuel Cell Materials," Fifth Quarterly Progress Report, Contract No. DA-36-039 SC-85-85384.
- 2. H. P. Gregor, "Fuel Cell Materials," Final Report, Contract No. DA-36-039 SC-85384.
- 3. J. Perry, Jr., Proceedings 16th Annual Power Sources Conf. (1962).
- 4. R. M. Lurie, C. Berger and R. J. Schuman, "Fuel Cells," Vol. 11, Reinhold, p. 143, (1963).
- 5. W. G. Taschek and J. E. Wynn, Proceedings 16th Annual Power Sources Conf. (1962).

# 3. Single 36 Sq. In. - Cell Studies

Two cells with tantalum pusher and separator plates are operating very well at 5 psig. For one of these cells, the effect of wide variations in gas rates on pressure drop and polarization curves were determined. The rate of liquid appearance in the gas compartments was also checked. Two unusual cells were placed on stream to help pin down the source of the liquid found in the gas compartments.

Detailed results are given in Table 2.

### 3.1 Effect of Pressure Level

Cell E-1282 and Cell E-1268 were identical cells except that E-1268 was run at a nominal 16 psig and E-1282 at a nominal 5 psig. As reported last month, when 4 amps were drawn from E-1268, the cell voltage did not maintain its initial value of 0.79 v but fell to 0.632 v in 120 hours. The lower pressure E-1282 on the other hand maintained voltage very well - reading 0.748v after 288 hours. This improved voltage maintenance was ascribed to smoother operation of the cell at the lower pressure level. Unfortunately, the hydrogen flow path became obstructed after approximately 300 hours: hydrogen would no longer flow through the cell and the cell failed. Inspection of the cell after dismantling did not disclose the nature nor exact location of the blockage.

### 3.2 Effect of Well-Balanced Pressures

In view of the improvement in operation obtained by reduction of the pressure level (Cell E-1282), a cell was put on stream with particular effort to keep inter-compartment pressure differences during startup and operation to a minimum (Cell E-1651). This cell has maintained a voltage of close to 0.8v at 4 amps for over

500 hours. The polarization curves obtained after 168 hours are produced in Figure 3. Note that the hydrogen electrode suffers from "concentration polarization" at about 50 amps/ft<sup>2</sup> while the oxygen is unaffected at this current density. The tantalum pusher and separator plates in this cell appear to be giving excellent service.

The specific conductance of the cell showed a continuing slow decrease with time, as have all other cells. It is not currently clear whether this is due to gradual membrane fouling, electrode deterioration or some other degradative process.

### 3.3 Source of Liquid in Gas Compartments

To determine the source of the liquid observed in the gas chambers and in the gas outlet lines in a qualitative way, two unusual cells were built. The first cell (E1279) had non-permeable pieces of rubber in place of membranes. This would allow leakage from the electrolyte ducts, hopefully to the same extent as in the regular cell, but would prevent transport of liquid through the membrane.

The second cell (E-1652) had an electrolyte chamber isolated from the gas compartments so that liquid could only reach the gas compartments by passing through the membrane. Liquid collection bottles were provided for all exiting gas streams of both cells.

After three weeks operation, the quantity of acid found in the collection bottles of the cell with the impermeable membrane-substitutes was equivalent to only 4 cc of electrolyte on the oxygen side and 12 cc on the hydrogen side. This demonstrated that with the present gasketing system, the acid <u>leakage</u> between compartments by way of the manifolds, ports, etc., can be kept to negligible levels. On the other hand, the collector bottles on each of the gas streams leaving the cell with the external electrolyte flow circuit (E-1652) had collected several hundred cc's of liquid during the same three week period. The liquid had definitely passed through the membrane.

## 3.4 Rate of Liquid Appearance

The rate of liquid production from the gas compartments were measured on cell D9228. These data are presented in Figure 4. The average sulfuric acid concentration in the liquid collected in the hydrogen side is 6N and in the oxygen side is 4.5N. The data presented are after 24 hours of operation when the cell had achieved reasonably steady operation. By taking the slope of the curve, an average value for the rate of liquid production can be obtained. The hydrogen side curve produces a consistent 0.6 ml/hr; the oxygen side was less consistent (possibly due to intermittent liquid holdup) but an average value of 0.63 ml/hr can be obtained. The rate of water production by reaction is 1.35 ml HpO/hr.

## 3.5 Effect of Varying Gas Rates

Pressure drops across the gas compartments were measured for various gas flow rates in cell D9228. These data appear in Figure 5. At 5 psig and 25°C, the cell uses 22 ml/min of hydrogen and half the quantity of oxygen at four amperes. At twenty times these gas rates, the pressure drops were only 30 mm H<sub>2</sub>O on the O<sub>2</sub> side and 20 mm H<sub>2</sub>O on the H<sub>2</sub> side. The energy loss even at very high gas recycle rates would thus be quite low. Polarization curves were also measured on cell D9228 with carefully controlled flow rates to determine the influence of gas flow rate on cell performance. Flow rates of 140 and 500 ml/min on the hydrogen side, and 50 and 200 ml/min on the oxygen side were compared. The polarization curves, Figure 6, show no detectable difference up to a total current of 10 amperes (40 amp/ft<sup>2</sup>). These measurements will be extended to 25 amperes.

## 4. Multi-Cell Battery Design Modifications

In the light of results with single cells, design modifications have been made in the radial porting of the gas and electrolyte compartments.

## 4.1 Gas Compartments

In the case of the gas compartments, the object has been to reduce the chance of gas-electrolyte leakage and to obtain better gas distribution to the parallel-connected cells. To this end, the minimum distance between the radial gas ports and the electrolyte port has been increased from 5/16" to 1/2". In addition, the number of inlet ports has been reduced to one, and its width reduced from 0.060 in. to 0.030 in. with the object of producing a higher hydraulic pressure drop and thus better gas distribution.

## 4.2 Electrolyte Compartment

With these components, the cut-and-cover technique for forming the radial electrolyte channels has been replaced by drilling a simple hole. It has proved difficult to maintain surface smoothness tolerances with the previously used, glued compartments. To permit the use of a drilled port it has been necessary to increase the thickness of the compartment from 0.060" to 0.100". In the case of the exit channel at the top of the cell, two parallel holes have been included to reduce the possibility of blockage by a gas bubble. (See Drawing number 2). A single inlet port with a cross-sectional area of about 0.0008 sq. in. will replace the two former inlet ports which had a joint cross-sectional area of 0.0036 sq. in. This was done to increase the hydraulic resistance and thus the efficiency of electrolyte manifolding.

## 5. Multiple-Cell Battery Component Procurement

## 5.1 Gas and Electrolyte Compartments

It has been decided to make at least one 5-cell battery out of Halon and one out of Penton. Because of the long delivery period for the non-standard thickness required for the electrolyte compartment, sufficient material has been ordered to permit the construction of a 10-cell battery in either plastic. Delivery has been promised for 15 March 1963.

### 5.2 Gasketing

From corrosion studies, it is expected that Dacron-reinforced Viton will prove to be a superior gasketing material. However, it has not been employed extensively in single cells as has Buna N. For this reason, it has been thought advisable to have a reserve stock of Buna N gaskets, which, though not ideal, would be expected to last the 100 hour life requirements of the batteries.

### 5.3 Electrode Manufacture

New plattens have been designed and materials ordered for their fabrication. The new plattens will permit the making of electrodes with one pressing operation in place of two, thus presumably permitting production of more reproducible electrodes.

## 5.4 Pusher and Separator Plates

Corrosion studies have shown tantalum to be the most resistant metal (other than platinum) to corrosion in  $6N_{\circ}H_{2}$   $SO_{4}$ . However, both niobium and zirconium have promisingly low corrosion rates. Since both these metals are less costly and lighter than the tantalum, it was decided to assemble at least one 5-cell battery containing some cells made with each metal.

#### 5.5 General Status

The present state of procurement situation is summarized in Table 3. The technical task status and schedule is appended to the letter regarding manhours, dollar expenditures and commitments attached to this report.

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TABLE I

MEMBRANE STUDY - 4 SQ. IN. CELLS - 25°C

E 0224 61-AZG  ADL-11 61-AZG  E 1325 61-DYG  E 1327 61-AZL  E 1326 61-AZL-15  E 1330 61-AZL-8  E 1331 AMF-C-313  ADL-12 AMF-C-313	Cell	Cell Specific	Liquid Collected, mls/day				
NO.	гуре	Resistance Ohms	Conductance mhos/ft <sup>2</sup>	H <sub>2</sub> Side	0 <sub>2</sub> Side		
E 0224	61-AZG	0.31	116	negligible	0,13		
ADL-11	61-AZG	0.27	135	*	*		
E 1325	61-DYG	0.45	80	0.14	0.29		
E 1327	61-AZL	0.26	138	1.44	2.6**		
E 1326	61-AZL-15	0.45	. 80	0.56	1.17		
E 1330	61-AZL-8	0.38	95	0.16	0.12		
E 1331	AMF-C-313	0.33	109	0.03	0.03		
ADL-12	AMF-C-313	0.35	104	*	*		
ADL-13	AMF-C-60	0.38	95	*	*		

<sup>\*</sup> Not measured at A.D.L.

<sup>\*\*</sup> On dye test, the membrane showed a pinhole.

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TABLE 2 Single 36 Sq. In. Cell Tests

REMARKS	*Cell restarted after being shut down 140 hours due to malfunction in control system.  **Recorded after cell had been off test 144 hours and restarted.  Test discontinued due to poor performance after restarting.	after cell had been shut off and restarted. discontinued due to block- outlet channel.	Cell discontinued following 100 hours of operation. Except for accumulations of liquid in gas compartments, no changes were noted as a result of operation.
	*Cell restarted 140 hours due t control system. **Recorded after 144 hours and r Test discontinu	*Recorded after 72 hours and re Gell test disca age of H <sub>2</sub> outle	Cell discontinue of operation. Etions of liquid no changes were operation.
Spec. Cond. M /Ft.	. ₹8	145 123 109 109 79	121 125 65
Time Hours	4 24 48 66 87	24 24 25 120 123 240 240 240 240 240 312 384	75 75 148 148
Average Voltage	0.548 0.602 0.602 *0.712 *\$0.570	0.772 0.782 0.762 0.755 0.755 0.780 0.758 0.744 0.744 0.748	0.762 0.780 0.702 0.598 0.638
Amps	4.0	4,10	4.0
Press.	91	5	16
Temp.	09	60	30
Cell Components	Sintered Kel-F Electrode Std. Memb.	Flectrode Std. Memb.	Sintered Kel-F Electrode Std. Memb.
Cell No.	E1279	E1282	E1292

TABLE 2 (Cont'd)

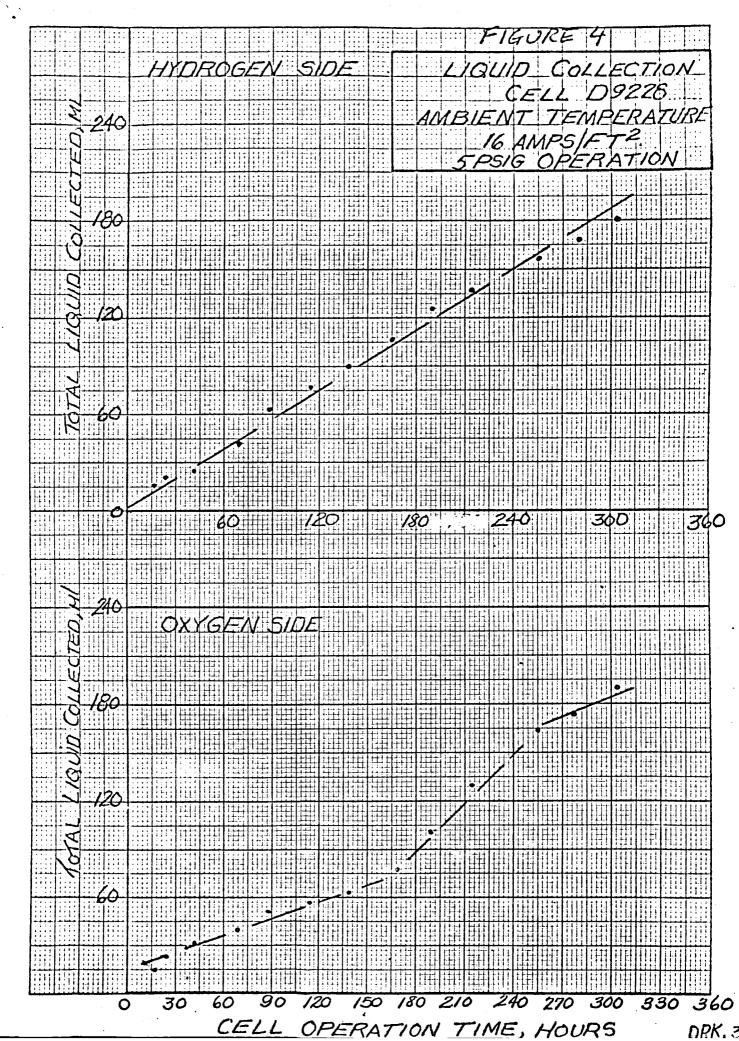
Single 36 Sq. In. Cell Tests

REMARKS	Still Running	*Cell is run only during day. Still running
Spec. Cong. Mhos/Ft.	266 178 182 132 121	
Time Hours	756 758 758 758 758 758 758 758 758 758 758	108 108 108 108 108
Average Voltage	0.812 0.848 0.848 0.847 0.826 0.808 0.782 0.783 0.791 0.791 0.785	0.648 0.382 0.578 0.578 0.632 0.738 0.738
Amps	0.4	4.0 4.0
Press.	· M	
Temp.	9	09
Cell Components	Sintered (Teflon) Electrode Std. Memb. Tantalum Pusher of Collector Plates	Sintered (Teflon) Electrode Std. Memb. Externally Fed PVC Electrolyte Compartment
Cell No.	E1651	E1652

TABLE 2 (CONT'D)

Single 36 Sq. In. Cell Tests

REMARKS	Still Running
Spec. Cond. Mhos/Ft.	158 129 98 102
Time Hours	220 120 144 144 168 216 264
Average Voltage	0.783 0.716 0.772 0.772 0.738 0.756 0.728 0.729
Amps	4.0
Press. PSIG	<b>w</b>
Temp.	Room Temp.
Cell Components	Sintered (Teflon) Electrode Std. Memb. Tantalum Pusher and Collector Plates
Cell No.	D9228



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TABLE 3

Status of Components for 5-Cell Batteries

			000	2000	DELIVERY	FABRICATION	AT ION	OK FOR ASSEMBLY
COMPONENT	ሲገሃ	MAIERIAL	URDERED	RECEIVED	DAI E	O EN I	אבר ט	
End Plates	9	Stainless Steel	Yes	Yes		Yes	Yes	Yes
Tie Bolts	36	Stainless Steel	Yes	Yes		Yes	Yes	Yes
Nuts & Washers	72	Stainless Steel	Yes	Yes	ese des	Yes	Yes	Yes
Springs	36	Stainless Steel	Yes	Yes		Yes	Yes	Yes
Gas Compartments	20	Penton Halon	Yes	0 N 0 N	15 March 15 March	8 8 8	8 <u>8</u>	
Electrolyte Compartments	22	Penton Halon	Yes	O ON	15 March 15 March	0 N 0 N	o o	
Gaskets	89	on-Dacron Buna .N	Yes	Yes	`	Yes	Yes	Yes
Insulators	9	Butyl Rubber	Yes	Yes		Yes	Yes	Yes
Pusher Plates	20 4 8	0.010" Tantalum 0.010" Niobium Zirconium	Yes	No Yes Yes	11 March	No 4 March 4 March	0 0 0 2 X X	
Separator Plates	20 4 8	Tantalum Niobium Zirconium	Yes Yes	No Yes Yes	11 March	No 4 March 4 March	8 8 8 0 0 0	
Electrodes Gauze Catalyst	30	80 Mesh Platinum Platinum Black	Yes	Yes	·	0 0 0 0	0 0 2 0	
Membranes	20	61 AZG 61 AZL	Kes s	0 0 0 V	14 March 14 March	O O	9 9 2 2	

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	PURSE								
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13 45	132.0	1	34.2	80.0	130	118/20	3.0	0	
1257	PURCE		30.5 7	و برج					
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	PUPSE	, Rom?	S. 7 70	29.8					
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	PUESE		31.0 %			-			
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1527	PURKE	FNOM	295 7	ک روق					·
1530	141.5	138.5	33.0	98.5	193-	128/27	3.0		
1592	# 1R33	FROM	595 70	29.0					
1545	141.0	140.0	32.8	100.5	19.2/82	13/132	2.5	.5	/
1557	PURSE	F. 3217	397 1	205					
1600	129.5	137.5	<b>.</b> ∃o	100.5	172 122	3 12 13 1	≓ . ⊅		
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7	PURGE	FEOM	32.8 70			. /			<del></del>
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1792	PURSE	FRUE	33.27	36.5					
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1007	PURGE	FROM	33 0 7	5261		25			
1100	1505	144.0	35.5	38.0	19/193	130141	3.0		
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	1530	150.0	35.4	37.0	196	19-			
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1442	FURGE	FRESTA	31.5 1/2	ÇH .					
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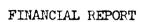
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LUID H	104 Car	78" 2 11's					***************************************			



for

FEBRUARY - 1963

(Contract NAS 3-2551)

Submitted by

NEW PRODUCT RESEARCH of TAPCO

(Attachment to Monthly Progress Report No. 8)



## FINANCIAL REPORT

for

Contract NAS 3-2551

for

Period Ending February 28, 1963

	Current Month	Total To Date
TRW Engineering Hours	<b>2</b> 86 <b>.</b> 5	169 <b>7.</b> 0
TRW Costs and Commitments	\$ 4,595	\$ <b>2</b> 6,680
Subcontractor Costs and Commitments	14,220	121,985
TOTAL	\$ 18 <b>,</b> 815	\$ 148,665

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